

The Carolina Engineer



SCHOOL OF ENGINEERING
University of North Carolina

MAY, 1933

VOLUME 1

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G-E Campus News



IN A PADDED CELL

RESearch moves in devious ways its wonders to perform. G.E. has a padded cell in its general engineering laboratory at Schenectady—for the isolation of extraneous sounds. Confined in it, at intervals, are motors, fans, and other equipment which serves best when heard least. The cell is a room within a room. The outer wall is of sound-absorbing plaster; then come hollow tile, air space, felt, another layer of plaster, more air space, sheet iron, air space, lathwork, and a thick layer of cotton waste. Total thickness, a foot and a half. Within the chamber a “noise meter” tracks down outlawed decibels.

Last year, the noise meter left its padded cell and traveled to Manhattan’s Metropolitan Opera House. Ensconced in a grand tier box next to that of Manager Giulio Gatti-Casazza, it measured voices, orchestra, and applauding hands while “Rigoletto” was sung. The meter discovered that Beniamino Gigli registered 77 decibels,—a street car in full progress makes only 65. Laboratory devices do have their big moments.



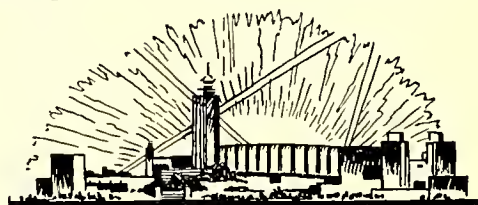
FORE!

“WOW! What a drive! If I could hit ’em like that, I’d sure break a hundred.” Just a few comments as a national driving champ smacked a golf ball out of sight. Occasion—the demonstration of a new G-E device for measuring speeds heretofore not measurable because of their nature. The apparatus registered the speed of the champ’s club head at 125 miles per hour; an average player is lucky to register 70. No wonder the champion can hit them so far.

The ball is driven from a low platform. Just back of the ball, two parallel beams of light are at right angles to the path of the club head. Each beam hits an “electric eye” or photoelectric tube. A split second before striking the ball, the driver cuts the first

beam, and almost immediately afterwards cuts the second beam. Both phototubes operate Thyatron tubes, the first one causing a condenser to begin charging and the second one stopping it. The charge is measured by a meter which is calibrated in terms of miles per hour.

And don’t worry about swinging too fast. H. W. Lord, who perfected the apparatus, says it will measure speeds up to about a thousand miles per hour. What a drive that would make! Incidentally, Lord is a ’26 grad of the California Institute of Technology.



“A CENTURY OF PROGRESS”

THIS summer, if you go to Chicago, you will visit an Aladdin fairyland; “A Century of Progress” will be the greatest night exposition ever held. You will see a veritable aurora borealis, artificially produced. Walter D’Arcy Ryan, veteran G-E illuminating engineer, is working in Chicago to help make the exposition the most spectacular ever seen. And well qualified for the job he is. An engineer-artist—schooled at St. Mary’s, in Halifax—he has directed the illumination for many similar events. When you go to Chicago, you will agree that a masterpiece has been created.

And you should not miss the G-E “House of Magic,” the most amazing part of the General Electric display at the exposition. There, recent discoveries and developments of our Research Laboratory will be presented in a fascinating manner. “Bill” Gluesing, a ’23 grad of the U. of Wisconsin, will have charge of the lectures and demonstrations. In addition, many G-E machines and appliances in the great circular hall of the electrical building will dramatize the rapidity of electrical progress. We’ll see you at the exposition. Remember, it’s from June 1st to October 31st.



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GENERAL ELECTRIC

The Carolina Engineer

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UNIVERSITY OF NORTH CAROLINA

VOLUME I

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STICK TO IT

In less than two weeks the technical schools of the country will graduate hundreds of men who desire to enter some field of engineering. It seems that at present industry cannot absorb all these men. At least all of them cannot enter work of a direct engineering nature as they have planned for the past four years. But this should not discourage those who are really fitted for a career in engineering. In fact it is claimed by the leaders in the profession that many of the greatest engineers have started in periods of depression just like the one from which we are now emerging. Such conditions seem to bring out the best qualities that the men possess, to make them work harder for advancement. The student entering the profession at present will probably have to start lower down than those who graduated four years ago; but if he sticks to his work, continues his education through all possible channels, and takes advantage of all opportunities, he has a good chance of gaining the position he seeks when the wheels of industry are again turning at normal speed.

So let's not be discouraged. Let's get out and show the whole engineering profession that the 1933 graduates can make just as good engineers as the 1928 graduates. We may start in a grocery store or a service station; but we'll get ahead before long. We'll keep our courage up and our wits with us; and we'll show the engineers that they can rely on a Carolina man. Pessimism doesn't help anyone. Courage is the word. So stick to it and come out on top.

A SUGGESTION

The great difference between the student of engineering and the man in the profession is that the latter has acquired a great wealth of experience. Theoretical training fills an essential place in the training for the engineering profession. This training can not be replaced by the knowledge given by experience; but if the theoretical training is to be of any real value, it must be supplemented by that knowledge which experience alone can give. It follows that the acquiring of experience in the field of engineering is something which must be done by every man who expects to progress far in the profession. The student should be alert for all chances to add to his store of the knowledge of experience.

Many people contend that the obtaining of experience can be accomplished only by the old trial and error method. This is surely true in a great number of cases. But there is a way to supplement and make easier the acquiring of experience

through individual trial. Reference is made to the utilization of the experience of others through the vast store of printed material recording other men's thoughts and works. Through that readily accessible source, technical books, periodicals, reports, etc., much of the valuable experience of the men in the profession is made available to the student. A little time spent in the library will prove a wonderful source of information. The library of the School of Engineering is equipped with great numbers of books and all of the best technical periodicals. They are arranged so that they may be found easily. And in case the student has difficulty in locating the publication for which he is looking, the librarian in charge will gladly give assistance.

Use the library service. You will find that it is interesting and instructive. And the knowledge found there may prove of great value both at present and in the future.

CARRY ON

With this issue the present staff of THE CAROLINA ENGINEER turns over the journal to the men who will carry it forward through the next year.

It has been the purpose of the staff this year to make a beginning; it is up to next year's staff to carry on. But the staff alone can make little headway. Only through the cooperation of the entire engineering student body can THE CAROLINA ENGINEER be made a journal which is a credit to the school, a publication to which the students can point with pride. With the engineering students giving their best efforts to support the journal there is nothing to prevent rapid advances during the second year of its existence. Without the backing of the students any outstanding accomplishments are impossible. The cooperation of the entire student body has been good this year; but it must be better next year. Every man must feel that it is his privilege and his duty to submit his best work for publication. Underclassmen should remember that the journal belongs to them as well as to the upperclassmen. It is only in this way that THE CAROLINA ENGINEER can become a truly representative organ of the engineering students.

The retiring staff hopes that they have given the magazine a start in the right direction. If they have succeeded, they are glad to have had the opportunity of giving their services; if they have failed, it is the duty of the students to see that the next staff makes the necessary corrections. In any event the staff makes no apologies. They have done their best, and they hope that their efforts have been successful. They give their best wishes to those who are to carry on.

Corona Loss on Model Transmission Lines

By J. R. MARVIN

One of the most important adjuncts to any power company is the model of its transmission system. The behavior of an existing long line or transmission system may be measured much more conveniently on a laboratory model than is possible by simultaneous measurements at distant points on the real line. Investigated behavior may relate to steady-state conditions or to transient states of electrical flow during disturbances; moreover from results obtained by measurements made on the model are determined the relay settings upon which depend the satisfactory operation of the system, the continuity of customer service, and the protection of expensive equipment. Not only may the electrical behavior of existing lines be determined easily and conveniently from tests on its model, but the behavior of a proposed line may be accurately predetermined from observations on its model in the laboratory.

In addition to these uses, model lines are used quite widely in technical schools and colleges to demonstrate the characteristics of transmission lines to students of electrical engineering.

A model line is an artificial electrical line constructed of such materials, dimensions, and parts that at certain assigned terminals it shall be the exact counterpart of the imitated real line. When such a model line is connected to suitable terminal apparatus, as a generator at one end and a load at the other end, the current, voltage, and power at the assigned terminals will be exactly the same as the corresponding quantities on the real line connected to the same apparatus. Generally, artificial lines are constructed to represent to some suitable scale the current, voltage, and power of the imitated real line.

As transmission voltages continue to be increased, the phenomenon of corona plays a more important part in determining the characteristics and behavior of transmission lines. Consequently, in building models of modern existing or proposed lines some means must be used to represent to scale on the model the corona loss on the imitated real line. It was with the object in view of simulating corona loss on a model line that the artificial line described in this paper was designed and constructed by the senior electrical engineering class at the University of

North Carolina under the direction of Mr. R. F. Stainback.

The model was constructed to represent conditions existing in one phase of a three-phase, 110-kilovolt, 250-ampere line constructed of 0000, seven-strand copper cable with a delta spacing of 13 feet. Calculations were based on a value of conductivity of 97.3 per cent at a temperature of 25 degrees Centigrade. The constants of this line are as follows:

Resistance, $r = 0.3495$ ohm per mile

Per cent resistance = 0.1373 per cent per mile

Inductance, $L = 0.002199$ henry per mile

Reactance, $x = 0.829$ ohm per mile

Per cent reactance = 0.326 per cent per mile

Capacitance, $C = 0.01373$ microfarads per mile

Susceptance, $b = 0.00000518$ mho per mile

Per cent susceptance = 0.13 per cent per mile.

Using a scale in which one ampere on the model equals 50 amperes on the real line and one volt on the model equals 1000 volts on the imitated line, the calculated constants of the model to give the same per cent characteristics as the original line are:

$r = 0.01746$ ohm per mile

$L = 0.001098$ henry per mile

$x = 0.414$ ohm per mile

$C = 0.2717$ microfarads per mile

$b = 0.0001023$ mho per mile

With these constants, the full-load current on the model is 5 amperes and the rated voltage is 63.5 volts to neutral. This rating permits voltmeter currents to be neglected.

The model is made up of a number of sections, the inductance and resistance of each section being contained in a coil consisting of 158 turns of 14-gage enameled copper wire wound in concentric layers on a varnished wooden spool 3 inches in diameter and one inch long. The only insulation between the layers of wire is that on the wire itself. After winding, the coil was covered with two layers of friction tape, and the whole unit was then varnished. Each coil has an inductance of 2.55 millihenries and a resistance of 0.4045 ohm.

Capacitance is furnished by three Western Electric 21-AA telephone condensers of approximately one microfarad capacitance each connected in parallel on both sides of an inductance coil. This combination of capacitance and inductance

makes a section representing 23 1-3 miles of the imitated line.

Three of these 23 1-3-mile sections are mounted in a box 22 inches long, 12 inches wide and 7 inches high, giving a unit equivalent to 70 miles of the real line. The inductance coils are mounted at right angles to each other to minimize mutual inductance. A sufficient number of these sections were made to represent 280 miles of the original line, and at the end of each 23 1-3-mile section provisions are made for inserting instruments and measuring the current, voltage and power at that point.

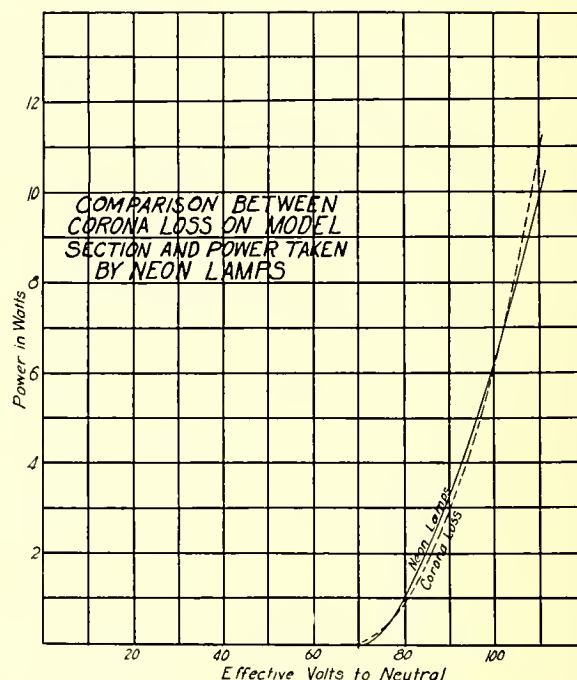
It was decided to attempt the use of neon glow-lamps to represent corona loss on the model, because the gaseous conduction phenomenon upon which the operation of the glow-lamps is based is similar to the phenomenon causing corona loss. It was proposed to put in parallel with the capacitance at each end of a 23 1-3-mile section a sufficient number of lamps to simulate half of the corona loss on that section. Several lamps having different starting voltages were to be connected in parallel to produce a resultant power-loss curve approximately identical with the corona-loss curve for 23 1-3-mile length of the model. Subsequent tests showed this plan to be entirely feasible.

Under conditions in which the density correction factor, $d = 0.967$; radius of conductor, $r = 0.232$ inches; delta spacing, $s = 13$ feet; disruptive gradient of air, $g = 53.6$ kv. effective per inch; irregularity factor, $m = 0.87$; and altitude = 500 feet above sea level, the effective disruptive critical voltage, e , for the real line is 68.1 kilovolts to neutral and the effective visual critical voltage, e , is 95.4 kilovolts to neutral. These values were calculated by Peek's corona formulae as given in Nesbit's *Electrical Characteristics of Transmission Circuits*. Since one volt on the model equals one kilovolt on the original line, corona loss on the artificial line should start at 68.1 volts effective to neutral.

To determine the proper combination of glow-lamps to be used, a number of the lamps were tested in the laboratory to ascertain the voltages at which they began to glow and the variation with the voltage of the power taken by individual lamps and by various lamps in parallel combinations. The results of these tests showed that the corona loss on a 23 1-3-mile section of the model could be very closely duplicated by connecting in multiple 4 lamps having a starting voltage of 71.5 volts, 6 having a starting voltage of 77 volts, and 6 having a starting voltage of 81.2 volts. The accompanying figure shows the close correlation between the corona loss for such a sec-

tion of the line drawn to the scale of the model and the power taken by the above combination of neon glow-lamps. To represent to scale in the artificial line the corona loss on the imitated line, 2 lamps with a starting voltage of 71.5 volts, 3 with a starting voltage of 77 volts, and 3 with a starting voltage of 81.2 volts are placed in parallel with the capacitance at both ends of each of the 23 1-3-mile sections.

When the model was originally constructed it was not known that it would take such a large number of neon glow lamps to represent the corona loss and provisions were made for accommodating only 2 lamps per 23 1-3-mile section.



The model is now being rebuilt with facilities for including in the circuit 16 lamps for each 23 1-3-mile length—a total of 192 lamps for the present 280-mile model. This requires a mounting space of approximately 5.33 square feet.

After completion, the four 70-mile sections were set up in the laboratory, and tests to determine the voltage and current distribution along the line were run for the following load conditions, stated in terms of the real line:

Load condition (1): Open circuit at the receiving end with Sending End Voltage = $63,500 + j0$.

Load condition (2): Short circuit at receiving end with Sending End Voltage = $63,500 + j0$.

Load condition (3): Inductive load with Receiving End Current = $150 - j150$ and Receiving End Voltage = $63,500 + j0$.

Load condition (4): Capacitive load with Receiving End Current = $150 + j150$ and Receiving End Voltage = $63,500 + j0$.

(Continued on page fourteen)

Boulder City

By SYDNEY FRANKLIN

With the advent of modern large-scale engineering projects requiring extended periods of time for their completion, a new and important factor has arisen which requires considerable consideration. It is the problem of "human engineering"; the problem of providing suitable food, clothing, shelter, sanitation, and entertainment for the workers during the period of construction.

An excellent example of a serious situation of this kind that has been successfully met, can be found at Boulder City, a model municipality that has been built to care for the men working on the Boulder Dam Project. When Six Companies Incorporated was finally awarded the contract for the construction of the major part of the dam, the first thoughts were toward the housing situation. An immediate need for a moderate-sized town grew out of the clause in the Hoover Dam contract which requires 80 per cent of the employees of Six Companies to live in this municipality.

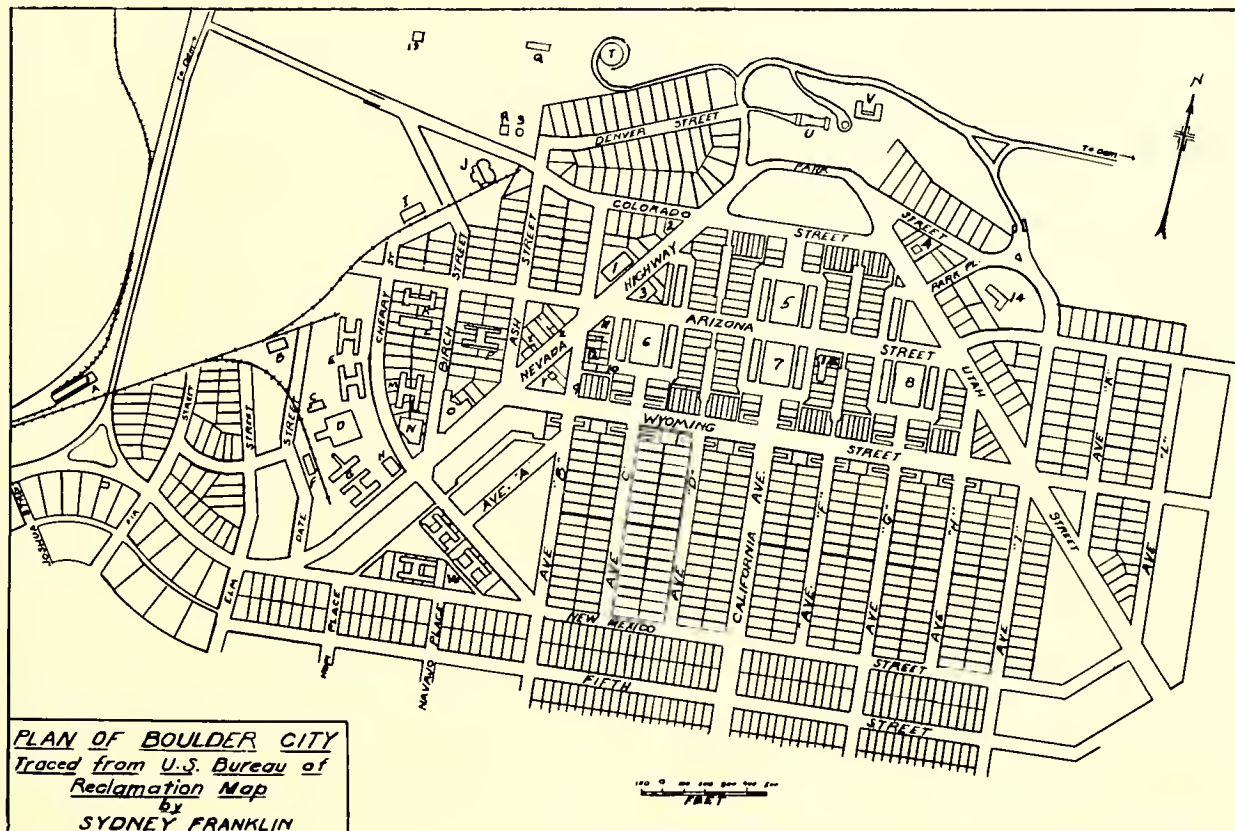
After a consultation between the officials of Six Companies and the U. S. Bureau of Reclamation, it was decided that the government should carry out the construction of Boulder City. For the use of certain portions of the city, the con-

tractors agreed to pay \$5000 a month. Since there is considerable doubt as to the future and ultimate size of the town, the government officials decided to plan the housing project only for the immediate future of 6 or 7 years, a period for which the existence of the city is assured by the terms of the original contract. The architectural and design work was entrusted to S. R. de Boer who planned this model city to hold comfortably 5000 people.

The city was built in a very short time at a cost of almost \$2,000,000. Practically all of the structures are permanent, as it was believed that after the completion of the dam, the numerous government officials and employees of the power plant who would reside there, coupled with the many visitors, sightseers, and tourists who would undoubtedly be at the city, would warrant such a move.

The site includes approximately 300 acres, and is laid out in a fan shape, with the administration building in the north as a focal point. The northern section of town is allotted to government buildings, and the residences of the Bureau of Reclamation employees are just below the focus point and on either side of the two main diagonal

(Continued on page eight)



Higher Education and Rural Life

By PROFESSOR NEIL P. BAILEY

Each year the most promising youths of rural communities are encouraged by their relatives, friends, and high school teachers "to go out into the world and succeed." Most of the advisers of these young people feel that the urban centers of population offer opportunities not present in their own rural communities, and consequently, they continue to urge the exportation of their most valuable youths.

From the time a college training is first suggested to a rural youth, until he has graduated and joined the ranks of the unemployed trained men of business, the professions, or politics, it is implied that such a course is the logical way for him to contribute his part to progress and to make his life worth while. For a man of letters to sell bonds is perfectly proper, but to return upon graduation to earn his living from the soil and become an active influence in the development of a rural community is to mark himself as a failure in the eyes of everyone, including himself. The influence of the lot of the old world agricultural peasantry is reflected in this situation, which is so contrary to our American ideals of equality and democracy.

This process of training the potential leaders of the rural communities and then encouraging them to join the ranks of the professional and business men of the cities has no counterpart in a compensating movement of high class urban youths being urged to return to the farms. Such a continued drawing of the best minds of one phase of national life to strengthen another is certain to ultimately cause serious differences in their rates of progress. The development and improvement of any community is governed largely by the average intelligence and industry of its inhabitants and the ability and vision of its leaders. Leaders possessing ability and zeal are indispensable in any case, for the inspiration and guidance of a few outstanding men will usually raise the level of any community, but no group has ever advanced rapidly without competent leadership.

The urban centers of America have always drawn heavily from the population of the rural sections for their phenomenal growth. However, in the past this, combined with wave after wave of pioneers pouring from both the rural and urban communities to settle up an ever-expanding frontier has only aided in a constant stirring action which would defy any tendency toward stratification of society. However, the disappearance of the last major frontiers has marked the end of such effective mixing of the people, and as the

population has become more static, a certain amount of stratification has already begun to appear. To appreciate this, one only has to have lived in a rural community of the west among the first generation of settlers, and then to have observed the rural population of the older states where this inflow of pioneers has long since ceased. Among the former were lawyers, doctors, teachers, skilled artisans, and preachers, while the latter is constituted chiefly of farmers representing several generations in the same locality, and often on the same land. This, in itself would be no particular cause for alarm, but when combined with a constant bleeding away of the most outstanding young people, it constitutes a really grave danger for the rural communities of America.

The era of territorial expansion and discovery which ended with the nineteenth century, idealizing, as it did, the hardy pioneer, had the effect of directing the attention of the youth of that time toward a rural life close to the soil. The era of rapid industrial, scientific, and business expansion which has marked the past thirty years, accompanied by its hero worship of the industrialist and business executive, has been accompanied by a steady flow of the best rural youth to the cities. An arts degree from a college has been considered good training for a salesman, but not becoming to a farmer. Few men, trained in business or science in college have been moved to apply their training to agricultural pursuits, and even the agricultural colleges have produced more research workers and government employees than dirt farmers.

It is just possible that the present economic collapse, aided by the judicious assistance of those who advise our youth in educational matters, may aid in directing more of the college-trained men and women back to rural communities. One of the most hopeful by-products of the present depression is in the fact that the rural youths who have graduated from colleges and universities during the past three years, finding no employment open to them in the cities, have been forced of necessity to gravitate back to their home communities and there to continue the threads of their lives at the point they were dropped when they left to attend college. To be sure, the majority consider this only as a temporary expedient, but, no doubt a great many of them will discover opportunities in their own communities which they never expected, and will realize the need there for people of their training and outlook.

The General Value of an Engineering Education

By PROF. W. J. MILLER

An engineering education is a highly desirable preparation for a life's work. This can be shown to be true, in spite of the present situation with regard to the employment of engineering graduates, by a careful examination of the available factual evidence on the subject.

To properly understand and evaluate the present situation with regard to employment of engineering graduates, a glance at the past history of the subject is helpful. Up to about the beginning of the twentieth century many technical graduates actually paid for the privilege of serving an apprenticeship in some industry. Then came the period of industrial expansion, which resulted in a sufficient demand for technically trained men to make the average initial salary paid by industries to engineering graduates \$800 in 1914. The next 10 years saw this starting salary rise to \$1476. From 1914 to 1929 the number of opportunities for the engineering graduate to enter industry increased until it was a common experience for almost any graduate to have three or four offers, and his only problem was to decide which to accept. It appeared that this state of affairs would continue indefinitely and engineering students and faculty began unconsciously to accept it as a normal condition.

The year 1929, with its decrease in employment in all lines of work, brought about a different state of affairs for employment of engineering graduates by industry. The classes from 1930 to the present have graduated to find the large industries unable to offer any employment, where formerly they would have offered to take the majority of the class. Very few of the members of these classes have as yet obtained employment in technical lines. A nationwide survey made by the Society for the Promotion of Engineering Education in the summer of 1931 showed that only about 20% of that year's class had been placed in lines similar to placements of the previous fifteen years. However, no evidence has yet been seen to show that this employment record is any worse than that of any other group of college graduates.

The National Industrial Conference Board Studies of 1924-25 gives information which shows how the graduates of the various branches of engineering were affected when the large industries ceased offering employment. These studies included a survey of 1081 establishments in the paper and pulp, textile, rubber, metal trades, chemical, and electrical industries, employing about 500,000 men. Of the total number of engineer-

ing graduates employed by these industries 40% were electrical, 20% mechanical, 14.3% chemical, and 1.9% civil engineering graduates. The remainder were divided between the minor fields of engineering. From this it can be seen that electrical engineering graduates were directly affected most and civil engineering graduates least by the withdrawal of large industry as a field of employment.

During the war and post-war periods of industrial expansion, engineering graduates, and to some extent faculty members, began to feel that the graduate was only properly placed when he accepted employment of a distinctly technical nature, usually with some large industry. Thus it was natural that engineering graduates and faculty were deeply concerned when such employment was no longer immediately available. Many graduates felt that their only course was to return home and wait until employment of a technical nature, for which they felt themselves especially prepared, should become available. These men have not had very happy experiences as a result of their failure to realize that an engineering training may be used to advantage in a great variety of activities.

In order to get a correct view of the type of employment for which engineering education fits a man, it is necessary to consider what has been the experience of engineering graduates of the past and also their opinions on this subject. With respect to the type of positions that engineering graduates hold in industry, the National Industrial Conference Board Studies, previously referred to, found that only 37.5% of the engineering graduates in the industries surveyed were engaged in strictly technical work, while 62.5% were distributed among such divisions as general officers, sales, production, etc.

Perhaps the most comprehensive and authoritative information on this subject is Bulletin No. 3 of the Investigation of Engineering Education as carried on by the Society for the Promotion of Engineering Education. The committee making this investigation canvassed some seven thousand engineering graduates of various institutions, and of classes ranging from 1884 to 1924. These were arbitrarily divided into two groups, first, the older graduates, about 2400 in number, of the classes 1884 to 1919, and second, the recent graduates, about 4,000 in number, of the classes 1922 to 1924.

It was found that as of January 1, 1925, 71% of the recent graduates were employed in pri-

marily technical positions and 29% in primarily administrative or commercial positions. Of the older graduates only 31% were in technical positions, while 69% occupied positions primarily of an administrative character. To quote from the report: "These figures show a healthy progression through technical work toward the responsibilities of management and also indicates that engineering courses fit graduates to a satisfactory degree for the responsibilities of the direction of American industry." . . . "It is obvious that this should be the normal path for engineering graduates to follow in their progress to responsible positions."

The older graduates were asked their opinions of the value of college experiences and their answers gave "knowledge of fundamentals of science," first with "discipline in methods of thinking and habits of work" a close second, while "direct training in engineering" was fourth.

From the foregoing it is seen that the engineering graduate of the past has in general first gone into strictly technical work and as he matures and acquires sound judgment to go with his "discipline in methods of thinking and habits of work," resulting from his engineering education, he is almost invariably drawn into an administrative position where his duties are largely the management of men, money, and materials. Thus it is seen that in the majority of cases the contribution of engineering education to the graduate that proves to have the greatest ultimate influence on his career is that of "discipline in methods of thinking and habits of work."

There is no evidence available to show that the engineering graduate may not be able to mature and gain judgment in other than technical employment and eventually emerge as the graduate of the past into administrative positions of trust and responsibility. In support of this possibility Mr. George B. Thomas, Personnel Director of the Bell Telephone laboratories, makes the statement: "Such an education is applicable not only in the field of engineering, but in other lines of endeavor as well, for it establishes habits of first gathering the factual data and then of analyzing these data to reach logical conclusions."

Since his training in engineering education, from actual record, has given him definite traits essential in the successful executive, the young engineering graduate who is willing to enter any commercial organization which offers a future, has chances for ultimate success above the average. This leads to the obvious conclusion that, whether the graduate follows technical or non-technical fields, an engineering education continues to be one of the most desirable preparations for a life's work.

BOULDER CITY

(Continued from page five)

streets. At the junction of these two main streets there is a 5-acre park from which the two streets run to the two far corners of the town, thereby forming the main routes of traffic. Between these two arteries is enclosed most of the city proper. Practically all of the land to the west is rented by the Six Companies for the use of their employees, while that in the south is given over to general residences.

Every effort has been made to keep the streets as clear to city traffic as possible. In the business section, which is in the center of the city, four plazas for parking automobiles have been constructed, and no street parking will be allowed. Numerous alleys have been built in the business section so that the loading and unloading of trucks can be done in the rear of the stores, thereby keeping them off the main highways. All through traffic is sent around the city on special through highways. All these through roads, as well as the main business streets, are 92 feet wide, while residential and other minor streets are 60 feet wide. In the residential sections nearest to the business district, the blocks are 900 feet long and 260 feet wide, and contain interior plazas and small parks suitable for use as playgrounds.

In the city the government has built a \$60,000 administration building, a \$45,000 municipal building and post office, a \$33,000 dormitory for unmarried workers, two garages, a fire station, a schoolhouse, and 100 residences with from three to seven rooms for married employees. Most of the 600 buildings are of brick or stucco, but a few are of tile or wood. An extensive \$600,000 program of landscaping is being carried out, which, when completed, will add considerably to the beauty of the city. A complete system of water distribution and sanitary sewerage has been completed, which necessitated the laying of over 23 miles of pipe line. At an expense of \$500,000, equipment was installed to pump water from the Colorado River to the city six miles away, elevate the water 2000 feet, remove its muddy color, and treat it chemically. Besides the government-built structures, Boulder City has two club-rooms, two messhalls, a recreation center, two warehouses, a machine shop, and a \$30,000 hospital. Most of these latter structures were built by the Six Companies or by private firms to whom contracts were awarded for the work.

The greatest difficulty confronted in the construction of the city was the extremely high temperatures that prevailed for 5 months of the year. During these five summer months, the tempera-

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The Story of Rubber

By T. R. TAYLOR, JR.

Many years ago in the mythical period following the creation of the "Aladdin Lands" of the tropical jungles of America, an Indian, perhaps at play, perhaps at war, or perhaps in search of food, discovered rubber latex. He found it oozing from the bark of a tree, and, having convinced himself that it was by no chance edible, lost all interest, except that of curiosity, as the strange substance congealed into a sticky mass in his hands.

The Indian probably gathered rubber sap for several days, or perhaps from a number of trees, until he had enough to shape into a small spherical mass. After playing with this for some time, the nameless native probably threw it to the ground and was much amazed when it rebounded. He probably picked it up, examined it more closely and summoned his tribesmen to see the new wonder. Perhaps some sort of game developed in those early days. Later, we know, the Indians developed and named this new-found plaything "batos," meaning ball. The substance from which it was made they called "cahuchu" or "caucho," which, translated, means "weeping tree."

Such is the mythical tale of the discovery of rubber.

Columbus was the first white man to learn about rubber. When he returned to Spain from his second visit to America, he told how the Indians played with a bouncing ball made from the gum of a tree.

It was nearly three centuries later, in 1770, that Priestly, the discoverer of oxygen, while experimenting with a mass of rubber given to him by a friend, accidentally discovered that this substance would erase lead-pencil marks. He was so pleased with his discovery that he cut the substance into small pieces and gave them to his friends, calling the pieces "rubbers." This incident has the historical distinction of having given rubber its name, and this was the first commercial use of rubber.

For many years the uses of rubber were extremely limited because of its hardness and brittleness in the cold of winter and its softness and stickiness under summer heat. In 1839, however, it was discovered that rubber mixed with sulfur when heated lost its detrimental properties and became a suitable material for the production of many serviceable articles. This process was called vulcanization. Since that time thousands upon thousands of new uses have been found for rubber as well as many ways of combining it with other materials to serve particular

purposes, and today there is hardly a civilized community anywhere in the world where rubber is not used to serve industry or to add to the health, comfort, and pleasure of the people.

Until 1912, the advent of plantation rubber, the world's supply of rubber was obtained from wild shrubs, vines, and trees, the best grades being obtained from the Hevea tree of Brazil. The plantation industry resulted from the farsightedness of Sir Henry Wickham, who was commissioned by the British Government in 1876 to obtain seeds from Brazil, which were planted in Kew Gardens, in England. Later the young trees were transplanted to Ceylon, where the climatic and soil conditions were favorable and they developed rapidly. Seeds from these trees were subsequently used exclusively for extensive planting throughout the Far East.

The business of planting rubber trees for profit developed slowly. When, however, it became apparent that considerable demand existed for crude rubber from trees planted and cared for in a systematic manner, large areas were planted rapidly. The success of these plantations attracted widespread interest and, in a short time, considerable acreage was developed in British Malaya, the Dutch East Indies, and Ceylon.

In the course of a few years vast areas of jungle land were cleared of native trees and planted in rubber. The extent of the plantations in the Far East at the close of 1929 is indicated in the following table:*

	Acres
British Malaya	2,944,478
Dutch East Indies	3,153,011
Ceylon	540,000
India and Burma	171,000
Other Countries	825,850
Total	7,634,339

These plantations produced about 626,181 long tons of rubber in the year 1928 and 833,720 tons in 1929. During each of these years the native rubber produced in the Amazon Valley and the rest of the world was about 33,000 tons.

In most rubber-producing plants rubber occurs in the form of an emulsion, a liquid resembling rich milk. To this fact it owes its name, "latex." When the leaves or stem of the milkweed are broken a rubber-bearing latex, very similar to that from which rubber is obtained commercially,

* A Wonder Book of Rubber, B. F. Goodrich Rubber Company, Akron, Ohio, U. S. A.

oozes from the broken surface. The latex from the Hevea tree contains about one-third of its weight of rubber.

Tapping a tree for latex consists of cutting out a narrow strip of bark with a gouge similar to that used by carpenters. The first groove, about one quarter of an inch wide, is cut from a point about four and a half feet from the ground diagonally downward one third around the tree. The groove is channelled at the bottom with the same tool and the latex which oozes from the tree along the cut flows along the channel through a metal spout at the lower end into a porcelain cup about the size of an ordinary teacup.

About an hour after the cut is made the latex stops flowing. Subsequent tappings are made on alternate days by cutting a thin strip of bark from the surface of the channel, exposing new surfaces from which latex flows. The production channel is thus lowered about one inch a month. Nature immediately starts replacing the bark where cuts are made and by the time the tapping cuts are close to the ground the first cuts are covered with new bark suitable for tapping once more. This cycle of tapping may be continued indefinitely. Trees are still yielding latex after thirty years' continuous tapping.

The latex does not flow in a stream from the tapping cuts. It drops at the rate of about two drops a second from a fresh cut, gradually diminishing in an hour to about one drop a minute. The total amount of latex from each tapping is about one fluid ounce containing one-third ounce of dry rubber. The annual yield per tree is about four pounds. It requires approximately the output from two trees for a whole year to supply the rubber for a small pneumatic tire weighing about twenty pounds.

The curdling of warm milk with vinegar is very similar to the process used for coagulating the rubber from the latex. Usually the entire day's production of latex from a plantation is combined in a tile or earthenware tank, the tanks varying in capacity from one hundred to one thousand gallons, depending on the number of trees on the plantation. After an equal volume of water is mixed with the latex, a half pound of acetic acid diluted with water is added for each hundred pounds of rubber content. If light-colored rubber is desired a little bisulfite of soda is introduced at the same time to bleach the rubber. Immediately the latex begins to thicken; in fifteen minutes it is set to a slimy consistency, and in half an hour it is jelled. After two hours all the rubber is "coagulated."

To make the grade of rubber known as "pale crepe," the coagulated latex is squeezed between corrugated iron rollers revolving at unequal

speeds, and at the same time is washed with a stream of water. By this squeezing a straw-colored whey, or serum, entirely free from rubber, is removed and a strong elastic sheet of wet rubber is obtained. This sheet is squeezed and washed again between a second set of rollers set close together. It emerges as a thin sheet of rich yellow color with a crepe surface. To remove the twenty per cent of water still held in the crepe, the sheets are hung on poles in large, airy rooms, and dried about three weeks.

If the grade known as "ribbed smoked sheet" is desired, the washing is carried out between smooth iron rollers revolving at even speed to produce a smooth sheet of wet rubber about 14 by 24 inches in size. It is then run through rolls with corrugations in their surface which leave crossed ribbing of a diamond pattern on the surface of the rubber. This rubber still contains impurities which facilitate the growth of mold on the surface of the sheets. To avoid this the sheets are hung on racks in a loft and dried in the smoke of a wood fire.

The greater part of the rubber produced on the plantations is in the form of ribbed smoked sheets and pale crepe. Occasionally, due to certain irregularities in the collection of the latex or in coagulation, off-colored or streaked rubber results. Such lots are sold as faulty latex. Certain amounts of brown crepe, tree scrap, compo, and roll brown are also produced on the plantations from spontaneously coagulated rubber collected from the cuts in the trees, from the bark trimmings, or scraped from the buckets and tanks. There are many small tracts of land planted to rubber trees by natives who tap the trees and coagulate the rubber in small vessels in a rather crude fashion. The coagulum is sometimes passed through a set of hand rollers to produce plain unsmoked sheets but more often is simply pressed out into thick slabs. Most of this rubber prior to shipment finds its way to remilling factories where it is graded, blended, washed, and made up into thick crepe sheets known as amber blankets, ranging down to a dark brown from a light amber in color.

The great rubber depots in the Far East are located in Singapore and Penang, Straights Settlements; Medan, Sumatra; Batavia, Java; and Colombo, Ceylon. To these depots nearly all of the rubber produced on the plantations is forwarded. From these points it is shipped to London, New York, Amsterdam, and other ports. Eventually a large percentage of the entire output of the plantation finds its way to Akron, Ohio, and its vicinity.

Before rubber was produced on plantations

(Continued on page fourteen)

Power Logging in Western North Carolina

By E. A. GASKILL, JR.

An exciting industry that has flourished for years in the Appalachian Mountains is power logging. It is an industry which breeds strong, hardy men who love their dangerous work and find satisfaction in doing it well. These picturesque characters, however, are rapidly disappearing from the territory east of the Mississippi, for the industry is being strangled by the exhaustion of the forests and the creation of numerous national forests and parks. Indeed, the practical extinction of power logging in Western North Carolina occurred in 1928, when the state placed injunctions on three of the largest operations of this type, in order to stop timber cutting in the proposed area of the Great Smoky Mountains National Park, for the purchase of which negotiations were then under way.

Because of the rugged and precipitous nature of the Appalachian region, particularly Western North Carolina, power logging (wherein the logs are conveyed from woods to mill by machinery rather than by waterways or horse teams) was the only large-scale method feasible, for the water courses were shallow and obstructed by boulders and drifts. The machinery and equipment used consisted of railroads, log loaders, and skidders, the construction, operation, and maintenance of which involved a number of engineering problems, especially in railroad building.

The civil engineer employed by the logging operation had to solve a number of intricate problems concerning railroad construction, the first of which was the preliminary survey of the railroad lines. He had to choose a course for a road which would never exceed a six per cent grade for loaded trains and a ten per cent grade for empties; a course which would avoid a large amount of outcropping rock, to lower explosive costs; a course which would require a minimum of cuts, fills, and bridges; and a course which would reach the most timber per mile of track. After the preliminary survey, his next task was to survey the grade.

Grading was done with the aid of steam or gasoline shovels. Steam shovels proved more economical though more cumbersome to operate. Cuts and fills usually occurred together; so that the earth from the cuts was merely dumped into the fills. Grading preceded bridge building, which required much care.

Bridges were built with spruce uprights and hemlock stringers. As hemlock rots from the heart outward, it was necessary to bore holes through the stringers quite often to determine

their strength. When the walls of the hollow timbers were found to have a thickness of only three inches they were replaced by sound ones. New stringers were necessary every three to six years. The supports of the bridges were braced, when necessary, by stone-filled, diamond-shaped log boxes which deflected the force of the water and anchored the supports against the battering logs and boulders borne by the turbulent floods. Bridge building was closely followed by track laying.

Contracts for ties were issued to the inhabitants of the surrounding region, who skidded the ties to the grade with horses. Only hardwood ties were used. The steel rails were bought second hand. Track laying was not a difficult task, however; and it required little attention from the engineer.

The type of railroad most commonly built was the "high-line" road, a term applied to a road just under the mountain tops on a level with the gaps, and supplied with timber cut from both sides of the ridge. Low line roads or spurs would branch off onto the tops of every large leading ridge. In order to gain altitude from the mill to the high line road it was often necessary to resort to a zigzag course which involved the construction of back switches. Occasionally, when back switches were too numerous, an incline was built instead, on which the cars would be pulled up the mountain side by a cable engine. As back switches and inclines were expensive in construction and use, the engineer used them only when other means of gaining altitude were not available, and the timber values promised profits. Many logging operations have been absolutely ruined by poorly engineered railroads.

Because of the steepness of the roads and the heavy loads carried, a special type of locomotive had to be used. The engines were eight-cylindered Clyde or Shay geared locomotives. A set of four upright cylinders, a crank shaft, gears, and four driving wheels were on each side of the engine. Although they consumed coal at a tremendous rate, the engines were nevertheless powerful and efficient for the particular work.

The trains drawn by these engines consisted of open framed steel flatcars with short uprights at the sides, sheet iron floors at the ends, and a standard gauge track running the full length of the car. The cars were coupled together with a minimum of space between for rounding curves, because the space had to be bridged with short pieces of rail to enable the log loader to run on

the track on top of the cars from one to the other as it loaded the trains.

The log loader was similar to a steam shovel except that a cable with heavy, self-locking tongs hung from the end of the boom instead of the shovel. After loading or unloading, the loader and the last car were uncoupled and left for the next train. The loader was used for loading at places removed from the overhead skidders, and for unloading at the mill pond.

The skidders used were of two types, the ground-hog and the overhead. The ground-hog skidder was merely a steam windlass or cable engine. An endless cable carrying attachments to be fastened to the logs ran out and returned on a skidding trail cut for it. When all the timber by the trail had been cut, a new trail was made and the cable laid upon it. The ground-hog skidder was less efficient than the overhead and was used only in limited timber areas where it would not pay to set an overhead.

The overhead skidder was an imposing machine. It consisted of a steam engine which operated four or five drums, and a spar or inclined boom with its rigging. The rigging was composed of a main cable which carried a trolley, cables to operate the trolley, pulley blocks, and guy cables for the spar.

The skidders were kept mounted on flat cars to facilitate moving them. When moving, the spar was lowered to the roof of the machine with block and tackle operated by the engine and drums. Upon arriving at the new setting, the spar was raised by the same method and guyed by sixteen 1¼-in. wire cables. In spite of this heavy guying the spar occasionally broke loose and smashed the roof and its heavy frame work. After the spar was raised, the tail tree, which was a tall, sturdy tree across the valley that served in place of the spar for the far end of the main cable, was topped, trimmed, guyed, and rigged with block and tackle to carry out and pull taut the 2½-in. main cable. The completion of the remainder of the rigging was fairly simple. After the skidder had been set, operations were begun.

Axmen felled the timber under the cable. When they had four or five logs ready, they signaled the skidder with an electric bell or by shouting. The trolley would be sent out and a cable lowered from it, to which the logs were attached. Then the logs were raised from the ground, and trolley and load pulled in to the track where the logs were dumped in a pile. From this pile the logs were loaded one by one onto the trains by a rig smaller than, but similar to, the skidder rig. This loading apparatus was operated by the skidder mechanism. When all the timber had been felled

under the main cable, the far end was moved to a new tail tree near by, and operations were resumed.

The overhead skidder was more efficient than the ground-hog skidder or horse teams, for it could bring more logs to one landing from a wider area in any kind of country in a given time than the ground-hog skidder or horse teams. Often the main cable would stretch nearly a mile, enabling about 550 acres of timberland to be logged from one setting. At times the main cable would be suspended a thousand feet above the valley floor. Some of the men would ride to work dangling from the trolley in spite of the company's disapproval of such practices.

Although more efficient from the operator's standpoint, the over-head skidder spelled absolute destruction for the forest. In its wake not a bush was left standing and the acres of slashings invariably caught fire and burned with an intensity that, save for a few blackened, naked trunks, left only bare mountains, soon to be covered with blackberries and fire cherries. Imagine a 20,000 acre blackberry patch that does not grow a single edible berry. Such a field stands on the site once occupied by a beautiful spruce and hemlock forest on the head waters of the Pigeon River, destroyed by the prime essential of power logging, the overhead skidder. Power logging methods are the methods of the pioneer era of industry, when the cream of our natural resources was garnered without a care for the preservation of the remainder for future generations. I regret to admit that, in the interests of posterity, the extinction, in the Appalachian Mountains, of that most fascinating and dangerous of industries, power logging, is justified.

BOULDER CITY

(Continued from page eight)

ture stayed constantly above 100 degrees, a condition which made working conditions very unfavorable. For a time it was believed that foreign labor would have to be imported in order to cope with the heat, but due to the hurried building program, this situation was made unnecessary.

It is quite evident to note the importance of Boulder City in connection with the dam project. In fact, the actual construction work on the dam would be utterly impossible without some means of protecting the laborers from the unusual climatic conditions that prevail in that section. In spite of the fact that some people believe the life of Boulder City will be very short, many authorities have given proof that this model municipality has excellent prospects of developing into a moderate-sized city in the near future.

Activities of the Engineering Societies

A. I. Ch. E.

By F. H. LENTZ

The local student chapter of the American Institute of Chemical Engineers has been conducting regular meetings on alternate Tuesdays during the quarter. There has been quite a variety of programs directed along different lines. Probably the most interesting and instructive lecture of the quarter was delivered by Mr. Louis Shanks of the Ethyl Gasoline Corporation on "Anti-Knock Fuels." In his lecture, Mr. Shanks demonstrated the influence of various substances on the "knock quality" of gasoline. He also demonstrated a machine of the same type which is used in refineries in the determination of the "knock rating" of a gasoline.

Dr. E. E. Randolph, head of the Department of Chemical Engineering at State College, spoke to the chapter on "Different Views on Chemical Engineering."

The chapter voted to continue the Chemical Engineering Fellowship and Chemical Engineering Day at the University for at least one more year. The Fellowship is to carry the same stipend as last year.

Other activities of the chapter were composed of the regular business and the work done in cooperation with the other three engineering societies in the conduction of joint meetings.

A. S. C. E.

By F. C. CAIN

The activities of the student chapter of the A. S. C. E. have so far this quarter been confined to meetings. An inspection trip is to be made by the senior members to Roanoke, Va., later in the quarter for the purpose of seeing the steel mills and other industries there.

The first lecture was given by Dr. W. F. Prouty, head of the Geology Department of the University, on the formation of the earth and its structure with interesting references to prehistoric animals and their relation to establishing geological history.

Following the California earthquake the four engineering societies met jointly. Dr. Prouty and Professor T. F. Hickerson spoke on "Geological Mechanics of Earthquakes" and "Designing Buildings to Resist Earthquakes" respectively. The first lecture was illustrated by slides belonging to the geology department; the second was illustrated by drawings.

The four societies met again for a joint lecture by Mr. J. B. Watson, instructor, and J. R. Marvin, student, on the Chute a Caron project in Can-

ada. This project involved the construction of a concrete dam on end and later placing in position by dynamite and natural forces. Mr. Marvin discussed the hydraulic experiments necessary for this accomplishment. Mr. Watson described the project in general.

Tau Beta Pi tapping took place at this second joint meeting. President Allen MacLean presided. Franklin and Ridenhour, both members of the junior class, were tapped.

The remaining meetings of the A. S. C. E. will be devoted to planning the inspection trip for the senior class and to the election of officers for 1933-1934.

A. I. E. E.

By W. E. DAVIS, JR.

The A. I. E. E. has held only one regular meeting this quarter, that being on May 2. At this meeting the following men were elected officers of the Society for the coming year: President, C. M. Garrison; Vice-President, J. P. Irwin; Secretary, S. H. Usry; Treasurer, H. F. Stewart. Professor W. J. Miller was unanimously re-elected counselor for the Society at the meeting.

A large student delegation as well as all faculty members attended the spring meeting of the state A. I. E. E. at Duke University, April 7. At the meeting at Duke, interesting papers were presented on the operation of storage batteries, on condensers as storage batteries, and on the problems of a load dispatcher. A banquet was held that night, at which a number of Carolina students and faculty members were present.

A. S. M. E.

By PAUL R. HAYES

The meeting on March 1 was for the purpose of selecting an official delegate to the annual conference of southern student branches at Birmingham, Alabama. Three papers were read by their authors by way of competing for the selection. J. A. MacLean read his paper on "The Design and Calibration of a Liquid Tachometer"; A. C. Furchgott presented his "Experimental Determination of Wheel Streamlining Effect"; and G. W. Gorham read his paper on "The Influence of Ground Effect on Aerodynamic Drag in Wind-Tunnel Experiments." A committee consisting of Dean Baity, Dr. Howell, and Prof. Hoefer, selected Mr. Gorham as the chapter's delegate. At the Birmingham conference, April 1, Mr. Gorham won third prize in a large field with his paper.

The next meeting was a joint affair with the

other engineering societies and Tau Beta Pi. The picture "Blasting a Dam into Position" together with J. D. Watson's first-hand information on this project, and Rob Marvin's explanation of the preliminary scientific experiments, proved very interesting.

On April 25, the entire chapter journeyed to Raleigh for a joint meeting with the State College and Duke chapters. This session, held in the M. E. building at State College, was sponsored and conducted by the Raleigh Section of the A. S. M. E. On this occasion, two State boys gave interesting details of the mechanical seniors' inspection trip to Norfolk shipyards and to Langley Field. Then Mr. Gorham and the State delegate to the Birmingham conference spoke interestingly on their experiences.

On May 3, the chapter met to elect officers for next year. With surprisingly little politicking, Prof. N. P. Bailey was re-elected Honorary Chairman, and the following officers were elected without honor: Chairman, Paul R. Hayes; Vice-Chairman, Calder Atkinson; Secretary-Treasurer, M. F. Taylor.

CORONA LOSS ON MODEL TRANSMISSION LINES

(Continued from page four)

Load condition (5): Unity power factor load with Receiving End Current = $j0$ and Receiving End Voltage = $63,500 + j0$.

In performing the tests, the power input and output, the voltage and current at the sending- and receiving-end terminals, and the power, voltage, and current at the end of each of the 23 1-3-mile sections were read.

A comparison of the voltage and current distribution along the imitated line as obtained from the tests on the model with the voltage and current distribution as calculated with the exact smooth-line equations showed the distribution as obtained from the model for the five loading conditions named above to be an almost exact counterpart of the calculated distribution for corresponding loads.

The following table shows the comparison between the values of efficiency and regulation as obtained from the tests on the artificial line and as calculated with the exact equations.

Loading condition	% Efficiency		% R'g'lation	
	Test	Calc.	Test	Calc.
Load condition (3)	71.1	74.9	93.4	92.5
Load condition (4)	61.3	63.3	18.35	14.23
Load condition (5)	73.4	75.9	66.7	65.5

In conclusion it may be said that the results of the tests show that the model line duplicates very closely the behavior of the imitated line both in

regard to voltage and current distribution and in regard to efficiency and regulation. The tests also show that corona loss may be represented almost exactly in artificial transmission lines by using the proper combination of neon glow-lamps having the proper starting voltages. In the model the Electrical Engineering Department has a very valuable instrument for teaching the behavior of transmission lines both under transient and under steady-state conditions.

THE STORY OF RUBBER

(Continued from page ten)

where care is exercised in keeping it clean, practically all wild rubber was washed. Today usually only wild rubber or some of the poorer grades of plantation rubber are washed in the manufacturing plants, but when special cleanliness is demanded even the highest grades must be thus processed. The washer consists of a pair of corrugated rolls between which the rubber is roughly sheeted while a stream of water flows over it. Wetting the rubber reduces its stickiness and the particles of dirt are loosened and washed out. By repeated passages between rolls set closer and closer together, new surfaces are successively exposed and all the dirt is removed.

Rubber must be dried before it can be used in the subsequent factory processes. This may be done by hanging the wet sheets on rods in a dry room through which warm air is blown. This method is known as forced drying. Sometimes the sheets, lain on pans, are dried under reduced air pressure in a heavy steel-walled compartment fitted with steam-heated plates and connected with a vacuum pump—the vacuum drying process. In another type of drier which has come into common use, the water is removed from the rubber by blowing over its surface air containing about one-third of the moisture it would contain if saturated. Strange as it may seem, this partially moist air dries the rubber more quickly than "bone dry" air.

Every rubber product requires a particular kind of compound, special processes and methods of preparation. The mixture determines the texture of the product; whether it is a soft or hard rubber article. Hard rubber is characterized by its stiffness, hardness and lack of stretch; soft rubber by its flexibility. These differences are produced mainly by varying the proportion of sulfur mixed with the rubber and varying the time and temperature of vulcanization. The various ingredients making up a rubber compound are carefully weighed out into cans marked with a designated number and sent to the mixing room. In the mixing mill the rubber is squeezed between

two heavy, hollow iron rolls set 1-4 to 3-8 of an inch apart, forming a sheet which adheres to one roll and rotates with it. The large mills used for mixing rubber compounds have rolls 84 inches long with a capacity of 150 to 300 pounds to the batch. One of these rolls travels faster than the other and the rubber is torn and kneaded in passing between them. The mechanical action generates considerable heat and it is necessary to run cool water through the center of the hollow rolls to prevent the material from vulcanizing during the mixing process.

After the rubber is soft and plastic, other materials used in the compound are added and the milling continued until all are massed together and traveling in a sheet around the roll. The millman then cuts the sheet with a sharp knife, beginning at one end and rolling it on itself until he has cut almost completely across the mill. The roll thus formed is permitted to sheet out again on the mill and the process repeated in the opposite direction. By this process of cutting back and forth uniform mixing of all parts of the batch is procured. The last operation in mixing is "cutting off" in slabs about three feet by six feet. These slabs are dipped in soapstone to prevent their sticking together and are then ready for the next process.

Recently another type of mixer has been developed called the Banbury or "internal mixer." It consists of a pair of specially shaped rotors turning in opposite directions in a closed compartment. The rotors are so shaped that the rubber is moved back and forth in the chamber and the pigment forced into it both between the rotors themselves and between them and the compartment walls. The capacity of the larger units of the Banbury mixer is three to four times greater than the largest mills in use and the time required for mixing a batch is much shorter.

One of the machines used for forming rubber mixtures preparatory to final manufacturing operations is the calendar. This consists usually of three hollow rolls set one above the other and supplied with steam and water so that the temperature may be carefully regulated. For sheeting rubber, the speed of the various rolls may be uniform or one may travel faster, as on the mixing mill, but for squeezing the rubber mixture into cloth (frictioning), the upper roll always runs faster than the lower one against which the cloth travels. The rubber is thus forced and wiped into the meshes of the cloth. Sheeted rubber and rubberized fabrics are wrapped in cloth liners to prevent the layers from sticking together and then are sent to the departments where the various articles are built. Calenders vary in size and in the number and arrangement of the rolls.

Those used for shoe soles and uppers are small; those used for rubberizing tire fabric will accommodate fabric 60-90 inches wide.

There is a widespread impression among the uninformed general public that rubber goods are formed by pouring molten material into molds, a process similar to that used in the steel industry. This, however, is not the method used, as unvulcanized rubber mixtures are relatively hard and tough when cold and remain rather stiff and doughy when hot.

Some articles, such as heels for shoes, hot water bottles, and bath caps, are formed by pressing unvulcanized rubber compounds into hot molds to be given their final shape and to become vulcanized, or cured. Other articles, as tires, tubes, hose and footwear, are built up by hand or machine from sheets of unvulcanized compound, fabric, and other materials and then pressed into hot molds for vulcanization. Another method is to deposit rubber on forms from rubber solution in benzol, the solvent evaporating before the goods are vulcanized. The most recent method of forming articles is by the electro deposition of rubber on forms from emulsions in water. This is the "anode" process. These methods are used in making gloves, bottle nipples and similar articles. Jar rings and other flat products are stamped from unvulcanized rubber sheets. Articles made by these methods are placed in steam, water, acid vapor, or hot air for curing.

Probably the most widely known rubber articles are automobile tires and tubes. In the making of pneumatic automobile and airplane tires, strips of frictioned or rubber coated cord fabric cut on the bias to the proper width are stretched around a collapsible flat iron drum or, for some types of tire, around a steel core the size of the proposed casing. A bead, that part of the tire which holds it on the rim, is placed on each side and additional layers of rubberized cord fabric stretched on. These layers of fabric and the beads are rolled smooth, the heavy cord breaker strip, tread and sidewall are applied, and the raw tire is removed from the drum or core. A heavy rubber bag is inserted in the tire to give it its shape and for internal curing. The tire is then placed in a steel mold into which the tread design has been cut. Twenty-five to thirty-five of these molds are lowered into a vulcanizer. A sectional metal tube connects valves in each bag. After the cover is securely fastened to the vulcanizer, live steam is forced into it.

Just prior to the entrance of the steam into the Vulcanizer, the bags are filled either with steam which is later displaced by hot water, or they are immediately filled with hot water under high pressure. Thus heating occurs not only

from the steam surrounding the molds but also from inside the bags, insuring a uniform vulcanization throughout the tire. The pressure inside the bag extends it, forcing the rubber on the outer surface of the tire against the sides of its mold to form the tread design and firmly compacts the whole tire structure. After sufficient time has elapsed for vulcanization, the steam is blown off, the molds are elevated and conveyed one after another around a platform where the lids are lifted and the tires removed in their finished state. The air bags are removed and the tires are then trimmed, cleaned, inspected, and wrapped with paper for shipping in the form of package familiar to the consumer.

Recent years have brought great improvements in methods of manufacturing inner tubes. The tube vulcanized on a straight metal mandrel and later spliced together at the ends has largely disappeared. The present method produces tubes vulcanized in circular form without visible end splices; the surface is smooth throughout and the circular mold form-fits the tube for the casings without creasing or wrinkling.

The rubber compositions for inner tubes are sheeted on a calender and cut to definite width and length. A reinforcing pad for the metal valve attachment is applied to the rubber sheet and a hole cut for the valve stem. The sheet is then fitted around a flat building drum, the ends lapped slightly and rolled together to make a complete band, and the valve inserted. The edges of the band are folded toward the center, lapped slightly and rolled together to form a circular tube. The molds in which these tubes are vulcanized are ring-shaped with steam chambers surrounding the mold proper forming the inner wall of the steam jacket. The outer sections of the molds are hinged to open sidewise to permit insertion and removal of the tubes. The unvulcanized tubes are inflated to definite size and slipped over the inside half of the mold. The mold is closed, the tube further extended by air to fill the mold cavity and after only a few minutes' vulcanization the tube of definite size and with smooth surface is removed. All tubes are thoroughly inspected before packing.

The interesting story of rubber is practically endless, but this brief outline gives a general idea of the processes of the industry from the tapping of the rubber tree to the selling of finished tires. Much of the progress of the rubber industry in recent years is due to chemical research, particularly the devulcanizing process and organic accelerators for vulcanization, as compared with the haphazard manner in which vulcanization was discovered by Goodyear when he dropped some

ENGINEERING STUDENTS OPPOSED TO REPRESENTATIVE ON STUDENT COUNCIL

By J. F. GEIGER

On May 10 a mass meeting of the engineering school was held to decide two important questions: namely, "Should THE CAROLINA ENGINEER be continued?", and "Should the engineering school be represented on the student council?"

The motion to carry on THE CAROLINA ENGINEER under the present plan of organization was carried by an overwhelming majority. W. E. Davis and H. F. Stewart were elected editor and business manager respectively for the next year.

The next question, that of having a representative of the engineering school on the student council, has been used in the past by various political organizations on the campus as a plank in their platforms with the hope of obtaining the votes of the engineers. But it is doubtful that many votes were secured in this way, because the engineers showed by a unanimous vote that they were against the proposal. It was generally felt that the disadvantages of the proposition outweighed the advantages. By obtaining a representative on the student council the school of engineering would make the first step toward segregation from the rest of the University. It would then be considered a branch instead of an integral part of the University as it now is. Many disadvantages would result from such a segregation. The engineering students would lose their votes in campus elections, their class privileges, their eligibility to Phi Beta Kappa, and their right to enjoy the benefits of certain loan funds which are not open to the professional schools.

Realizing these disadvantages, and further realizing that such a plan would merely add more unnecessary offices to the already crowded political structure of the campus, the engineers voted down the proposal.

It is hoped by all earnest and interested engineering students that in the future the campus political organizations will find out definitely the attitude of the engineering students toward their proposals for the engineers before they include the proposals in their platforms. It can easily be seen that a man may be elected to office on a platform containing a plank particularly obnoxious to the engineering school even though the entire engineering school should vote against him.

crude rubber and sulfur on a cookstove by accident. At present it seems probable that the rubber industry will continue by leaps and bounds with the introduction of new processes, articles, etc., and also due to the exceedingly low price of crude rubber at the present time.



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